Supporting information to:

Soil organic carbon and soil organic matter measurements across habitats from the UK and Spain

Overview

Title	Soil organic carbon and soil organic matter measurements across habitats from the UK and Spain
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Spatial Extent	Terrestrial extent of the UK and Northern Spain
Temporal Extent	One off sampling campaigns in 2005-2009, 2018, and 2020
Summary	This dataset includes measurements of total soil carbon, soil organic carbon and soil organic matter for soil samples from Spain (AI4SoilHealth project), England (Biosoil project) and the UK (CINAg project). Soils were sampled to different depths based on the project's requirements. The datasets is part of a bigger dataset to investigate the fraction of soil organic carbon (SOC) in soil organic matter (SOM), denoted as f_{OC}, as a national-scale soil process indicator.
File Name	soc_som_spain_biosoil_cinag.csv
File Format	.csv

Data structure

The dataset consists of 15 columns and 1044 rows. The meta-data is provided in the table below and descriptions of the three datasets is presented below. Cells without values show "NA".

Column name	Unit	Description	Calculation
Dataset_name	none	Dataset name (Spain, Biosoil, CINAg)	
Country	none	Country the soils data originated from	
LOI_method	degrees Celsius	temperature used to measure Loss-on-ignition (LOI)	
ID	none	unique identifier for the soil sampling location	
Habitat	none	assigned (unified) broad habitat based on the UKCEH Countryside Survey	
Soil_category	none	Assigned: Permafrost, sediment, mineral (SOM < 20%), organic (SOM > 20%)	
Depth_low	cm	soil core depth within ID; ID's are associated with soil profile and depth	
LOI_perc	percent	measured soil organic matter content	
TC_perc	percent	measured total soil carbon content	
SOC_perc	percent	measured or calculated soil organic carbon content	
f_tc_or_soc	unit less	calculated fraction of total carbon or soil organic carbon in soil	TC_perc/g soil or SOC_perc/g soil
f_soc	unit less	calculated fraction of soil organic carbon in soil	SOC_perc/100
f_som	unit less	calculated fraction of soil organic matter in soil	LOI_perc /100
f_c_in_som	unit less	calculated fraction of carbon (total or organic) in soil organic matter	f_tc_or_soc/f_som
f_oc	unit less	calculated fraction of soil organic carbon in soil organic matter (this is the subset of f_c_in_som filtered for SOC)	f_soc/f_som

Dataset “Spain”

As part of the European AI4SoilHealth project (https://ai4soilhealth.eu/) soils were sampled from the Spanish pilot sites, mainly featuring Improved and Neutral grasslands, but also Coniferous woodland. Four sites were sampled for four different land uses from the topsoil 0-20 cm. Each land use was at least sampled in three replicates per land use. Total carbon was determined using dry combustion (elementary analysis, ISO 10694:1995) and was corrected for $CaCO_3$. Soils were dried at room temperature and sieved to 2 mm prior to SOM analyses. Samples were analysed on a TGA (TGA 8000, PerkinElmer. IR: PerkinElmer Spectrum Two), where data on Loss on Ignition (LOI) at 375ºC and $CaCO_3$ contents were extracted (Lebron et al., 2024).

Data were collected as part of the project AI4SoilHealth under the UK government's Horizon Europe funding guarantee [grant number 10053484]

Dataset: “Biosoil”

Forest Research BioSoil forms a large EU forest soil and biodiversity survey, which was undertaken during 2005–2009 (Vanguelova et al., 2013). Sites were selected on the basis of the presence of woodland on a 16 x 16 km national grid and covered a wide range of tree species and soil types. In Great Britain, of the total of 220 BioSoil plots, 76 are in England, 32 in Wales and 112 in Scotland. One representative soil pit and five randomly sampling points were located within each circular plot (25 m radius), and the soil sampled incrementally down to 80 cm (0–5, 5–10, 10–20, 20–40 and 40–80 cm soil depths; soil horizon samples taken from the soil pit; (0 cm taken as the top of the mineral soil) and top of the peat horizon in peat/peaty soils using a Dutch soil auger. Sampling and analysis of biomass and C content of litter (L) and fermenting humus (F) and peat (H) horizons were taken in triplicate per plot. Soil sampling and analyses were carried out according to the UNECE ICP Forest Manual for Soil Sampling and Analysis (Cools & De Vos, 2020). Measurements and analyses performed on BioSoil samples include soil organic and inorganic C concentration for each soil horizon (L, F, H, A, B and C) and five soil depths (0–5, 5–10, 10–20, 20–40 and 40–80 cm). Chemical analyses were performed by the Forest Research chemical laboratory at Alice Holt, and quality was assured by rigorous EU interlaboratory comparison. SOC was analysed by dry combustion at 900°C using a C/N analyser (CE Instruments Ltd, FlashEA 1112 Series). LOI was determined at 375ºC for most of the English BioSoil plots.

Funding was provided through DEFRA tNCEA and FR for BioSoil - the national forest soil monitoring network

https://www.forestresearch.gov.uk/research/integrated-forest-monitoring/soil-sustainability-forest-focus-biosoil-project/

Dataset: “CINAg”

CINAg stands for “Virtual Joint Centre for Improved Nitrogen Agronomy” and was a BBSRC project run by Rothamsted Research (2016-2019). In 2018, nine sites across England, Scotland and Wales were sampled for topsoil (0-15 cm). Each site featured at least two contrasting land uses or forms of management (Table below).

In 2018, sites with different land uses and soil types were visited across the UK (Figure 2, Table 3). Some sites that were part of the UGRASS project (https://www.soilsecurity.org/u-grass/) were re-visited sites for soil sampling and the measurement of aboveground biomass productivity.

Soil was initially dried at 25ºC for 14 days. Soil organic matter (SOM) was measured as loss-on-ignition (LOI). A 10 g subsample was weighed into a crucible and put into an oven at 105ºC for 24 hours, the weight loss provides the soil water content. The same crucible with the dry soil was then introduced into a Carbolite furnace at 375 ºC for 16 hours, this second weight loss is quantified and reported as SOM. Soil water content and SOM were recorded in percent.

QA/QC: two laboratory standards (BS1 and BS3) and random replicates were run in each batch. Data were compiled in Microsoft Excel files and data were checked by another member of staff before data to the project manager.

Dried soil was ball-milled and used for total soil carbon determination. Ball milled soil samples were oven dried at 105°C (± 5°C) for a minimum of 3 hours, cooled and sealed prior to weighing. 20 mg of soil were weighed into a tin cup on a 6-place micro-balance. An Elementar Vario EL was used to measure total soil C and works on the principle of oxidative combustion followed by thermal conductivity detection.

QA/QC: All calculations were done by the instrument software and results expressed in % notation. The instrument's calibration is checked on use using a working standard (Acetanilide) with concentrations of 71.1% total C and the data corrected (factored) against these values. Two of these standards are analysed at the beginning of every run, with every 10 samples and again at the end of a run. At least two reference soils were analysed with each batch at intervals of every 20 samples.

Data was collected for the Newton Fund project "UK-China Virtual Joint Centre for Improved Nitrogen Agronomy". Funded by Biotechnology and Biological Sciences Research Council (BBSRC) and NERC - Ref BB/N013468/1. https://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/

Table: Sites visited in the CINAg project, and Land uses sampled within each site across the UK; Site x Sampling point code identify the soil profile ID in the dataset.

Site	Land uses	Sampling point
Parsonage Down	Pristine & cattle grazed Intensively grazed Wheat cultivated	1001 1002 1003
Silwood	GL un-limed no nutrients GL un-limed with NPK	213 214
Harpenden	Highfield: Arable wheat NPK Highfield: GL Fosters: Arable rotation Fosters: Reseeded GL Fosters: GL/arable rotation NPK Park Grass: GL limed pH7	1 3 10 9 11 38

	Park Grass: GL, limed, pH5 Broadbalk: GL mown Broadbalk: wheat + limed + NKMg	40 15 14
Wymondham (Strawberry farm)	Permanent pasture + low density sheep Floristically enhanced grass margin Arable continuous rotation	76 77 78
Plynlimon (Severn and Wye)	Acid GL/heathland lightly sheep-grazed Semi-improved GL, heavily sheep grazed Reseeded GL, heavily sheep grazed different areas: Acid GL sheep grazed (1) Acid GL sheep grazed (2) Acid GL sheep grazed (3)	O9 O8 O10 O6 O11 O12
Abergwyngregyn (Ffridd)	Semi-improved GL & sheep GL & sheep Acid GL	O1 O2 O3
Newborough	Sand dunes grazed Sand dunes grazing exclosures Sand dunes grazed, 53 years	O13 O14 O15
Easter Bush	GL sheep grazed GL un-grazed GL for silate un-grazed Arable crops oilseed rape Arable crops wheat	O14 O16 O16g O13 O15
Kirkton	Improved permanent pasture Reseeded GL Poor-semi-improved GL	201 202 203

Additional information

This dataset is part of a larger dataset used to investigate the use of two commonly measured soil metrics, soil organic carbon and soil organic matter, as a national-scale soil process indicator. Other datasets used for the comprehensive study in conjunction with the published here presented data are published elsewhere:

Reference to datasets	DOI
(Bentley, Reinsch, Alison, Andrews, et al., 2023)	https://doi.org/10.5285/821325f3-b353-4a51-8db2-6b2200d82aca
(Bentley, Reinsch, Alison, Brentegani, et al., 2023)	https://doi.org/10.5285/6a3382cc-f5f4-4d68-9517-c62fadd8af4f
(Bentley, Reinsch, Brentegani, et al., 2023)	https://doi.org/10.5285/af6c4679-99aa-4352-9f63-af3bd7bc87a4
(Reinsch et al., 2023)	https://doi.org/10.5285/d53fdf1d-767a-4046-821a-ea645001ddd3
(Bentley, Brentegani, et al., 2024)	https://doi.org/10.5285/fe58d52e-f00c-4895-a35e-26b7353cc275
(Bentley, Reinsch, et al., 2024)	https://doi.org/10.5285/38d6f5b4-4d03-4006-aa55-91894378ef27
(Reinsch et al., 2025)	https://doi.org/10.5285/deabe608-fc6e-4d3a-812f-fb08ae515121
(Toberman et al., 2016)	https://doi.org/10.5285/9305b068-f417-4659-9966-d9456f22c331
(Mitchell et al., 2020)	https://doi.org/10.5285/f539567f-a8cd-482e-89b8-64a951b52d93
(Reinsch et al., 2024)	https://doi.org/10.1038/s41597-024-03333-w
(Weber et al., 2021)	https://doi.org/10.1016/j.geoderma.2021.115189
(Weber et al., 2023)	https://doi.org/10.1002/saj2.20490
(Heikkinen et al., 2021)	https://doi.org/10.1111/ejss.13033
(Leifeld et al., 2020)	https://doi.org/10.1038/s41598-020-64275-y
(Palmtag et al., 2022)	https://doi.org/10.5194/essd-14-4095-2022
(Fourqurean et al., 2012)	https://doi.org/10.1038/ngeo1477

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